Wireless Network Analysis and Forecasting

Outputs

- Wireless ad hoc network research.
- Forecasting of future wireless technologies.
- Studies of WPAN to WLAN interference.

Wireless communication links are used to extend wired networks to solve the first mile/last mile connectivity problem. The advantages of economy and flexibility are making wireless data links more attractive relative to fixed infrastructure, which is more expensive to upgrade and whose inherent limitations restrict user mobility. Wi-Fi (wireless fidelity) networks essentially extend the range of wired networks, rather than operating as autonomous and/or independent networks. Wired networks are extended via wireless access points, where multiple wireless communication links connect to a central point. The nodes that make up a Wi-Fi network communicate through a wireless access point, rather than peer-to-peer. This topological similarity with wired networks does not exploit the advantages of wireless links, which posess the unique features of mobility and self association. Peer to peer communications, such as those defined in the 802.11 standard and Bluetooth, only partially take advantage of the self association characteristic of wireless communication. Self associating wireless networks are known as ad hoc wireless networks. ITS is examining the use of ad hoc wireless networks for use in Federal communications architectures. Research at the Institute is focusing on how to make these ad hoc wireless networks suitable and secure for Federal wireless users.

The Institute is actively investigating the kinds of wireless networks and services Federal users will be seeing in the future. These networks are being examined for suitability to interface to mobile government security services. In particular, common interfaces are being closely examined since they may aid in the rapid adoption of emerging wireless technologies. ITS is attempting to identify the interfaces, both software and hardware, that will allow a broad range of government wireless communications services to be developed and deployed. Future wireless networks, such as IEEE 802.15 and IEEE 802.16, which are on the verge of being fielded, promise to make broadband services widely available. IEEE 802.15 will support data rates of up to 54 Mbps with a range of tens of meters. This technology will provide the capability to send real-time video over

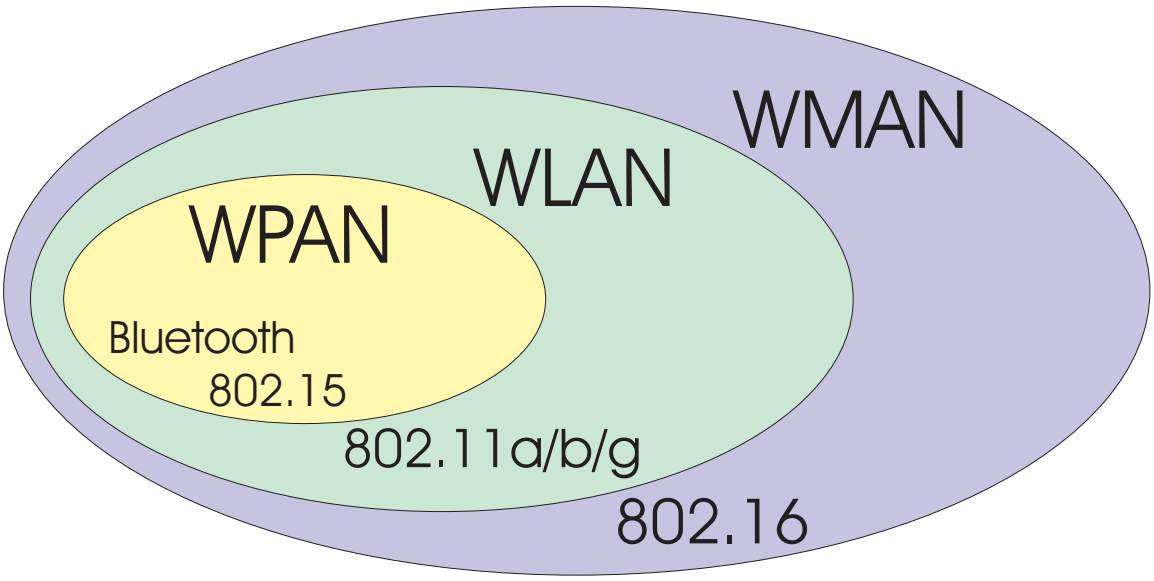

Figure 1. Hierarchical connectivity between wireless network standards

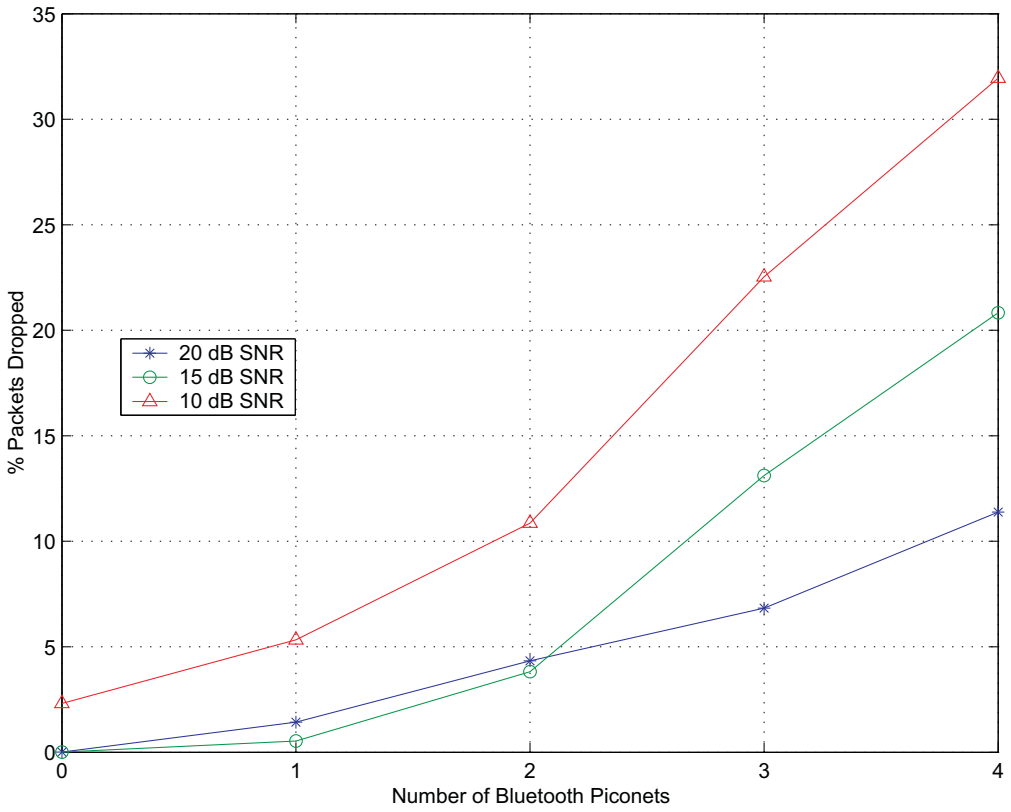

Figure 2. Percent packets dropped vs. active Bluetooth piconets.

piconets (small networks of devices) in the unlicenced 2.4 GHz band. Piconets are also identified as wireless personal area networks (WPAN). IEEE 802.16 is designed for data rates of up to 155 Mbps in a point-to-multipoint metropolitan area network (MAN). A MAN facilitates the connection of multiple wireless LANs over a range of 50 km. A hierarchical connectivity diagram of these networks is shown in Figure 1.

Another area of research centers on the interference between wireless network technologies. The Wi-Fi (IEEE 802.11b) and Bluetooth wireless networking technologies are widely available and are increasingly used in field applications when government data infrastructures do not exist. Unfortunately, interference between these networks can create vulnerabilities for government emergency services, particularly when these networks are used as ad hoc data infrastructures. Wi-Fi operates in the unlicenced 2.4 GHz band, uses direct sequence spread spectrum (DSSS), and supports data rates of up to 11 Mbps. It is typically deployed in networks ranging up to 100 meters in airports, homes and businesses. Bluetooth, which is also in the 2.4 GHz band, uses frequency hop spread spectrum (FHSS), supports data rates up to 1 Mbps, and typically operates in piconets of up to 10 meter range. Bluetooth piconets are used as wireless data cables to connect peripherals such as printers to PDAs or to connect headsets to handsets. Although these networks are designed for somewhat different applications, they are often found in the same area, and consequently may interfere with each other. ITS has been exploring the interference between these wireless networks by conducting a series of measurements. Figure 2 above shows the percentage of dropped Wi-Fi packets versus the number of active Bluetooth piconets. As the figure indicates, there is increasing packet loss on the Wi-Fi link as the number of piconets increases and the Wi-Fi link power decreases.

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